Fibre optics to conquer undersea exploration

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Undersea exploration and monitoring of natural resources is set to be revolutionised by acoustic sensing technology using fibre optics developed at ANU. The technology is 100 times more sensitive than current techniques and the optical fibre sensors can be deployed up to 100 kilometres away from the central recording station without significant degradation of signal quality.

Dr Mal Gray, Mr Jong Chow and Professor David McClelland, from the Centre for Gravitational Physics at ANU, working with Dr Ian Littler for the University of Sydney, developed the ground-breaking technique by applying ongoing fundamental research on the measurement and detection of extremely faint gravitational wave signals from outer space to the field of fibre optic sensing.

“This patented technology has tremendous potential for marine mineral exploration, monitoring of sea and gas reserves, as well as security and submarine surveillance,” project leader Dr Gray said.

The ANU led team bettered the world record in fibre strain sensitivity by more than a factor of 100 and has achieved this at the end of a length of optical fibre five kilometres long.

The sensor they have developed is able to detect acoustic waves with almost unimaginable sensitivity — roughly equivalent to being able to detect changes on the order of size of a human hair (100 micrometers) in the distance between the earth and the moon (385,000 kilometres), a level of sensitivity known as sub-picostrain.

“The combination of ultra-sensitivity and remote capability is what makes this technology truly compelling — we have developed the world’s most sensitive underwater microphone that can operate at the far end of many kilometres of fibre optic cable,” Mr Chow said.

When a piece of optical fibre “hears” a sound wave, the vibration minutely alters the fibre length. Laser light travelling down the core of the fibre can then be used to detect this length change and thus measure the sound waves. When two mirrors are placed at the ends of this fibre, forming an optical device called a “Fabry-Perot”, the laser light bounces back-and-forth many times, and so effectively magnifies the tiny length change. This is a technique used in gravitational wave detection, where scientists attempt to measure an extremely tiny warp in space-time due to massive astrophysical objects such as black holes and supernova.

To date, a system sensitive enough to interpret these minute changes in a sensor located at a significant distance away from the processing and recording electronics has not been available — and this is where the new ANU technology improves on the status quo.

“By using Fabry-Perot devices, created in the core of an optical fibre, coupled with advanced laser based signal extraction techniques developed by the ANU team over years of fundamental research into the detection of gravitational waves, we are able to both detect extremely weak sound waves and transport this information many kilometres with no loss in fidelity,” Dr Littler said.

According to the researchers, the new technology has applications in:
· Marine mineral exploration —The new technique improves on existing systems by detecting far weaker signals at further distances while reducing the weight and bulk of the deployed sensors.
· Oil and Gas reserve monitoring — long lengths of fibre sensors can be laid on the ocean floor, above oil and gas reserves. The new readout

system using the ANU technology means the fibre optic sensors can provide continuous monitoring of the reserves at a remote location on a drilling rig or other surface location.
· Security and submarine surveillance — improves the sensitivity of acoustic monitoring and the area that a single sensor cable can monitor.

“We are thrilled with the remarkable sensitivity of the device. This achievement underscores the value of ongoing fundamental research and the opportunities it presents for real-world applications,” Professor McClelland said.

While the researchers’ results have already attracted international interest, Benthic Geotech, a Sydney based Australian marine geotechnical services company was the first to approach the team regarding jointly working towards the commercialisation of the fibre sensors.

Chief Executive of Benthic Geotech, Mr Peter Williamson said: “We’re excited about the potential of this innovative technology for applications in the oil and gas industry, which includes our major clients. The technology will bring benefits both in oil and gas exploration as well as energy reserve management.

“Adoption of this technology could significantly alter the economics of marine exploration and would provide another example of Australian born technology enabling the discovery and development of new resources.”

Source: The Australian National University

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